Testimony:

Statement of Parviz Moin, PhD, Franklin and Caroline Johnson Professor in the School of Engineering, Stanford University
Committee on House Science Subcommittee on Space and Aeronautics

July 18, 2006

Mr. Chairman and the honorable Committee members,

My name is Parviz Moin and I am a Professor of Mechanical Engineering and Computational and Mathematical Engineering at Stanford University. My field of research is turbulent flow physics and computational aerodynamics and propulsion. I am the editor and on editorial boards of five international journals on computational methods and flow physics, which keeps me reasonably abreast of global research activity in these areas. Before joining Stanford as a faculty member, I did a Postdoctoral study at NASA-Ames and subsequently was hired as a civil servant research scientist there.

Mr. Chairman, in my testimony I will address the four questions that you asked me in your invitation letter of June 13, 2006.

1) In reference to Aeronautics Research Mission Directorate (ARMD) goals and strategies, I do believe that NASA's emphasis on foundational research is very appropriate. Foundational research is precisely what NASA should be doing; in fact, given the limited resources that the ARMD has been allocated, only foundational research is what it can do successfully. In my opinion, NASA's role in aeronautics research should be as a bridge between academia, which conducts fundamental research, and industry which ultimately ensures the preeminence of the United States in aerospace technology. As such, NASA should inspire and support the best minds in this country to carry out fundamental research relevant to aerospace industry. To be an effective bridge, however, NASA engineers and leadership should be of the highest technical caliber, in order to be respected and listened to by both academia and industry. In this regard, Administrator Griffin should be commended for appointing an outstanding technical team at the highest leadership levels of the agency. The Aeronautics Directorate should strive to preserve the technical expertise that remains at NASA, and more importantly, to make a valiant effort to replenish its technical workforce. In achieving this goal, NASA needs this body's help in alleviating some of the administrative constraints it is facing.

2) The main competitive technical challenge facing the civil aeronautics industry is the projected increase in air traffic capacity in the next 10 to 15 years, and the related performance and environmental issues such as noise and harmful emissions. Progress in these areas is very much dependent on a better understanding of the underlying physical phenomena and the subsequent development of the high fidelity predictive models. What is needed here is increased coordinated foundational research in these areas. Considerable emphasis for research along these lines in the recent NASA Research Announcement (NRA) which solicited basic and applied research proposals,

demonstrates that ARMD leadership is clearly aware of these foundational technical challenges, and is taking action to deal with them. The European Union has already taken the lead in devoting substantial resources to multi-national coordinated research programs for development of high fidelity predictive tools. In recent times they have been more open in trying new ideas and leading edge technologies. Japan has been sustaining a strong long term research program in aeronautics and especially in high speed flight, and China has recently expanded its research activity in aerospace science and technology. It is noteworthy that both countries have received major contracts from Boeing and in particular, Japan is manufacturing the main wing-box of the Boeing 787, its latest commercial aircraft.

Although it is not directly related to the near term competitive challenges facing the civil aeronautics industry, I believe, ARMD has a critical role to play in the area of hypersonics with application to both manned and robot space exploration missions. Foundational research in physics-based modeling is required for high speed large payload planetary entry, descent and landing. ARMD has the technical means to take the lead in this area, but the necessary resources, in my opinion, should be provided from the space exploration mission.

3) Computational science has been recognized as the third leg of the stool representing 21st century science, together with theory and experimentation. Computations enable us to investigate phenomena where economics or physical and environmental constraints preclude experimentation (see recent report of President's Information Technology Advisory Committee). The last twenty years have seen the rise of computer-aided engineering in almost every industrial sector. Today, many aspects of product development, design, optimization, performance analysis and certification rely heavily on the use of computations. Computers are also the latest resource available for scientific discovery. Over thirty years ago the visionary leaders of NASA and its highly acclaimed research staff pioneered the development of the discipline of computational aerodynamics and its transition to industry. Today computational modeling is an integral part of aircraft and engine design and is responsible for dramatic reductions in the required expensive wind tunnel and engine tests. However, in spite of its successes, computational engineering is far from being predictive for complex engineering systems. New high fidelity methods, physics-based modeling research, computer science, and validation and verification tools, including tighter coupling to laboratory experimentation are required before achieving predictive status.

   Over the past five years alone, the super-computer power has increased by two orders of magnitude. Because of this there now exists new opportunities to conduct high fidelity integrated computer simulations of complex engineering systems. Therefore, NASA is clearly correct to increase its emphasis on computational and physics-based modeling. NASA has invested in super-computer hardware and should continue to do so. There is also a clear emphasis in computational and physics-based modeling in NASA's recently released NRA.

However, to reestablish its historical preeminence in this area, NASA needs to retain its existing knowledgebase and build on it by carefully complementing and replenishing its workforce with young talented Ph.D. engineers.

A solid experimental program is vital for physics-based model development and validation of computer simulations. NASA should continue to invest in its unique facilities, and should cooperate with universities in small-scale laboratory experiments.

4) There does not appear to be any pronounced decline in the enrollment of graduate students in the top ranked aeronautical engineering departments and in related engineering fields in the U.S. However, a disturbing new phenomenon for NASA is that the agency appears to be a less attractive career choice for most of these highly skilled engineering Ph.D. graduates. Back in the late seventies when I joined NASA, the agency was considered a top, competitive career choice for many of the most talented engineers in the country. They were attracted to the agency for its unique research facilities and for working with, and being mentored by, some of the most illustrious technical leaders in aeronautics. According to the 2005 membership directory of the National Academy of Engineering, only two active employees of NASA's aeronautics field centers have the distinction of membership in the Academy. This is disproportionately low for the country's leading aeronautical research enterprise.

Finally, as you are undoubtedly aware, about one half of engineering Ph.D. graduates in the United States are foreign born. Due to various cumbersome and in my opinion, often unnecessary restrictions given, the current global economy, it is extremely difficult for this technical workforce to be employed by the civil aerospace industry or NASA. I believe, it is in our best national interest to embrace this enormous technical resource and provide opportunities for these U.S. graduates for postdoctoral fellowships in NASA, and employment in civil aeronautics industry and for eventual full citizenship.